

POTENTIAL
FOR
COAL-WATER-MIX FUEL
CONSUMPTION IN
A.I.D. - CLIENT COUNTRIES

FINAL REPORT

TO

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BY

Burns and Roe Company

Engineers and Constructors

Oradell, New Jersey 07649

The work and results described in this report represent the efforts of the following:

Charles Bliss - Program Manager, U.S. AID,
Office of Energy
Washington, D.C. 20523
Telephone (703) 235-8902

Egon A. Kimmel - Project Manager, Burns and Roe, Inc.
800 Kinderkamack Rd.
Oradell, N.J. 07649
Telephone (201) 265-2000/extension 2733

Martin Schmidt - Principal Investigator,
Burns and Roe, Inc.

Eugene Eng - Principal Investigator,
Burns and Roe, Inc.

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1.0 EXECUTIVE SUMMARY

This study was designed to assess the potential for Coal-Water-Mix (CWM) fuel utilization in countries with which A.I.D. has bilateral technical assistance agreements. The study was confined to the use of CWM fuel in oil designed steam generators used by the electric utilities. The analysis was based on overall electricity generation patterns in each country and general assessments of CWM conversion technology. No attempt was made to evaluate the suitability of individual steam generators.

A total of 69 countries were investigated in the course of this study. Four were identified as particularly good candidates for further study: Indonesia, Philippines, Egypt and Colombia. Twelve others were identified as less promising potential candidates for CWM fuel use. The total potential annual use of CWM fuel in these 16 countries was estimated to be equivalent to 140 million barrels of oil which is equivalent to nearly \$4 billion at current oil prices. It is recommended that these 16 countries be studied in more detail, individually and in regional clusters, to determine specific sites for future CWM fuel demonstration and use.

2.0 INTRODUCTION AND BACKGROUND

Although the present world wide oversupply of oil has lowered the official price, the strong U.S. dollar has kept the effective cost of imported oil very high for most developing countries because the price is set in dollars. Throughout much of the world, public policy is aimed at reducing dependence on foreign oil through the substitution of less expensive foreign fuels and the development of indigenous energy resources. Coal-water-mix (CWM) fuel could be used in some situations to reduce oil imports to developing countries. In addition, developing countries with petroleum resources could possibly increase their export potential by substituting CWM fuel for some of their domestic petroleum consumption.

3.0 OBJECTIVES AND METHODOLOGY

3.1 Objectives

This study was designed to assess the potential for using CWM fuel as a substitute for fuel oil for electricity generation in developing countries. The developing countries chosen for study are those with which AID has bilateral technical assistance agreements. The results of this study can be used to identify AID client countries that would benefit from further investigation into their potential for using CWM fuel. Particular attention was paid to the countries having significant indigenous coal resources, as these countries could realize the most foreign exchange benefits through the use of CWM fuels.

3.2 Methodology

This study was performed in three parts: raw data collection, analysis, and synthesis of results. The raw data was obtained from sources associated with United Nations agencies, the World Bank, U.S. Department of Energy, U.S.

Department of Commerce, equipment manufacturers, and trade publications. The raw data was reported in varying units and for different time periods throughout the sources. As much as possible, the information was put on consistent bases for comparison purposes.

The following data were considered to be the most important for this analysis for each country:

- o Economic Data - population, Gross Domestic Product (Table A-1)
- o Petroleum Consumption - total consumption of petroleum products for energy, consumption of fuel oil (Table A-2)
- o Commercial Energy Consumption - total production by utilities, mix of fuel types by utilities, production by industry (Table A-3)
- o Electric utilities - total installed capacities, total capacity factors, oil-fired capacity, oil capacity factors (Table A-4)
- o Coal Resources - total reserves, recoverable reserves, coal quality (Table A-5)

These data are reported in the statistical tables and were used to develop estimates for the potential for using CWM fuel as a fuel oil replacement. The results are given on a regional basis, with indications of the countries with particularly high potential.

A complete analysis of the CWM fuel potential in a particular country would require the following steps: a complete inventory of the country's oil fired boilers including their size, age, and suitability for conversion; electricity demand projections for the next 10-20 years; utility construction plans for the same period; oil cost and availability projections; and analysis of the suitability of domestic coals for CWM fuel preparation. This detailed analysis is beyond the scope of the present study. This study used existing data on electricity demand and generating capacity to identify the countries with the greatest potential for CWM fuel use.

Load duration curves were constructed for the electric utility industry in each country based on the current system annual capacity factors and on the capacity factors for the oil fired units. No attempt was made to predict the future load regimens of the oil-fired units; all analysis was based on present usage patterns.

When operating on CWM fuel, an oil designed boiler would be likely to be limited to less than its full capacity. This limitation, or derating, is dependent on the initial design of the boiler as well as the modifications performed to convert it to CWM fuel firing and the characteristics of the particular CWM fuel. Detailed studies of the conversion of oil-designed boilers to CWM fuel firing include an analysis of the trade-off between conversion cost and achievable boiler load. For the purpose of this study, it was assumed that 67% of full boiler load could be achieved at an economical cost in an oil to CWM fuel conversion.

To operate at a higher load, the converted plants would have to switch from CWM fuel to fuel oil. Therefore, the electricity generated at these higher loads was usually assumed to be generated completely by oil. However, if the installed capacity of the utility system in the country is large enough, more CWM fuel could be used by firing oil at fewer plants but at higher loads than indicated by the national averages. The CWM fuel consumption figures were increased to account for this possibility when appropriate.

Estimates for potential CWM fuel use in the industrial sector are much more difficult to develop. Industrial power generation equipment is generally less amenable to conversion to coal based fuel. The industrial market is outside of the scope of this study.

4.0 ASSESSMENT OF POTENTIAL

4.1 Africa

4.1.1 Regional Overview

Table A-1 gives general economic and energy information on the 31 countries in the AID Africa region. The total population of these countries is over 200 million. Petroleum products are used for 65% of the commercial energy (see Tables A-1 and A-2).

The developing nations in the Africa region still rely, to a large degree, on non-commercial energy sources such as fuel wood and animal wastes. Less than half of the energy in the region is supplied by commercial sources such as oil, gas, coal and electricity and this portion is even lower in the less developed nations.

The commercial energy resources of the continent include coal, oil, gas, and substantial hydroelectric potential. The coal resources are concentrated in the southern part of the continent. The oil and gas deposits are primarily in the northern part and near the western shore of central Africa. The large and small scale hydroelectricity potential in central and southern Africa is projected to have an increasing impact on the energy balance in the region.

The primary coal producer in the region is the Republic of South Africa. It exports about 35 million tonnes per year from its reserves of anthracite and bituminous coal that amount to about 25 billion tonnes (recoverable reserves). Zimbabwe is the only other major coal producer, with exports of about 0.1 million tonnes per year from a production of 2.8 million tonnes (see Table A-3). Botswana and Swaziland have substantial hard coal reserves but have only begun to develop these resources. There are indications that further large coal reserves can be expected to be discovered in the southern half of Africa in the near future. In the north, Algeria, Egypt and Morocco have small coal reserves.

The developing countries in this region are nearly all net oil importers. However, the recent high price of imported oil has stimulated some nations in the region, particularly Cameroon, Ivory Coast, and Zaire, to increase their exploration for petroleum reserves. These three countries increased their combined crude oil production two and a half times from 1980 to 1983. In most

countries in the region, public policy dictates decreased dependence on imported oil through fuel substitution including hydroelectricity development and development of indigenous oil resources.

4.1.2 Electric Utilities - Africa

Most of the electric utilities in this region are very heavily dependent on diesel generators and small combustion turbines for their power generation. CWM fuels are not suitable oil replacements in these installations. Hydroelectric power is also very important in this region. As indicated on Table A-4, the only countries in this region that have fuel oil fired capacity for electric power generation (steam) are Ivory Coast, Kenya, Senegal and Sudan. Important considerations for each of these countries are presented below.

Ivory Coast

The Energie Electrique de la Cote d'Ivoire (EECI) produces all of the electricity in the Ivory Coast. EECI has five hydroelectric stations with two more under construction. Its capacity also includes one combustion turbine and about 50 diesel generators scattered throughout the country. The one oil fired steam plant has a capacity of 214 MW. This is the only plant that could possibly be converted to CWM fuel.

Kenya

Kenya has an installed oil-fired electric generating capacity of approximately 100 MW. The steam generators range in size from 60,000 lb/hr to 300,000 lb/hr. All of them are D-type, water-tube designs with flat bottoms. This type of steam generator is difficult to convert to CWM firing. In addition, Kenya presently has a mismatch between its oil refining capabilities and its petroleum products requirements. If the residual oil usage in industry were reduced due to CWM fuel penetrations, this mis-match would be exacerbated. This would decrease the economic benefit of coal firing.

Senegal

The generation and distribution of electricity in Senegal is handled by Societe Senegalaise de Distribution d'Energie Electrique (Senelec). Electricity generation is from oil fired stations (150MW) and diesel generators (50 MW). Non-commercial energy sources account for about two-thirds of the energy consumption in Senegal. The fuel oil fired steam generators appear to be large enough to make conversion to CWM fuel feasible.

Sudan

The National Electricity Corp (NEC) supplies the electricity to the two interconnected grids in the Sudan. There are regional authorities that handle generation and distribution in the six isolated systems in the country. The oil fired capacity (steam) in the Sudan is only a small portion of the total generation, 30 MW out of about 230 MW. The recent severe drought has reduced the hydroelectric generation placing a greater burden on the steam and diesel plants.

4.1.3 CWM Fuel Potential - Africa

The two countries with the greatest potential for CWM fuel usage are Ivory Coast and Senegal. There is about 350 MW of oil fired capacity in these two countries that may be convertible. Conversion of this capacity would result in an annual displacement of about 300,000 tonnes of oil.

CWM fuel preparation and delivery may be a problem for these two countries since neither one is presently a coal consumer. Importation of raw coal and CWM fuel preparation within the country would require major capital expenditures. However, since both countries are on the Atlantic coast it is conceivable that prepared CWM fuel could be delivered. This fuel could be made on the African continent, in South Africa or Swaziland, or elsewhere. These countries would, however, lose some of the foreign exchange benefits of oil replacement with such a scheme.

4.2 Asia

4.2.1 Regional Overview

The ten countries in the AID Asia region had a combined population in 1981 of about 1.2 billion (see Table A-1). Traditional non-commercial fuels are still important in many of the countries in the Asian region. In Burma, Nepal, Bangladesh and Pakistan, 50 to 70% of the total energy consumed comes from traditional biofuels. Wood is also the major energy source in rural areas in India and Thailand. These fuels are primarily used for heating and cooking. However, the increased pace of industrial development and urbanization has greatly increased the dependence on commercial energy sources.

The important commercial energy sources in this region include coal, lignite, oil, natural gas, geothermal and hydropower. The two largest coal producers in the region are India and China. Pakistan, Indonesia and Philippines produce lesser amounts (see Table A-3) and Thailand is presently using its domestic lignite resources. Oil is a principal energy source in much of the region; 45% of the commercial energy consumed by the AID client countries in the region came from petroleum products (see Table A-2). Philippines is presently increasing utilization of geothermal energy and is about to begin operation of the region's only nuclear power plant.

Hydropower is already an important source of electricity generation for a number of countries in the region. In addition, the unexploited hydropower potential is likely to be in excess of 200,000 MW. However, in some cases, development of this potential will require international cooperation because of the locations of the potential sites.

In most countries in this region only a minority of the population has access to electricity. This minority numbers less than 10% of the population in Bangladesh, Burma, Indonesia, Laos and Nepal. The region's average per capita annual electricity consumption is only 172 KWh. The proportion of electricity in final energy consumption is 25% or less for the region. Although centrally generated electricity is still a small part of the energy picture in this region, its importance is expected to grow as industrialization and rural electrification programs continue throughout the region.

4.2.2 Electric Utilities - Asia

As shown on Table A-4, all of the countries in this region, except Fiji and Nepal, have oil fired electricity generating capacity. The best candidates for CWM fuel use in the region appear to be Indonesia, India, Pakistan, Philippines, and Thailand. Since the other countries in the region have less than 100 MW of oil fired capacity, they are not as attractive candidates.

Indonesia

Indonesia's central power generation is handled by the Perusahaan Umum Listrik Negara (PLN). Over 80% of its power generation facilities are on the island of Java. Although Indonesia has substantial oil resources, PLN is presently engaged in an extensive program to replace its oil fired capacity with coal firing. The country also has extensive coal reserves that it is beginning to develop.

Overall, Indonesia appears to be an excellent candidate for CWM fuel use. It is in the process of taking oil fired facilities out of service in favor of coal firing at other locations. Therefore, it will soon be in the position of having an operating coal handling infrastructure and a number of underutilized oil designed plants. In addition, centralized CWM fuel preparation on Java could permit the use of this fuel by smaller consumers throughout the country.

India

India's electricity generation is handled by a large group of public and private utilities. These systems are very heavily dependent on coal (58%) and hydro (37%) generation. India produces almost all of the coal that it burns; in 1982 net imports equaled less than one percent of the country's production. Although oil fired generation accounts for less than two percent of the national total, the savings possible from displacing 500 MW of oil fired capacity could make the CWM fuel option attractive to India.

Pakistan

The demand for electricity in Pakistan has increased substantially in recent years due to increased industrialization, farm mechanization and other social programs. The Water and Power Development Authority (WAPDA) has undertaken a program to develop the hydro resources of the country. However, due to the variability in river flows, WAPDA has built supplemental gas turbine plants. Even with this hydro development, over half of WAPDA's capacity is oil or gas fired. The other utility in the country, Karachi Electric Supply Commission (KESC), serves the city of Karachi and the surrounding area. It is almost entirely dependent on oil and gas fired capacity.

Pakistan appears to be a relatively good candidate for CWM fuel use. But there are two important factors to consider: Pakistan's coal reserves are sub-bituminous and lignitic in character which may be unsuitable for CWM fuel preparation. And, during the dry season, the country's hydro electric capacity is severely curtailed which could require the fossil units on the system to operate at high loads during the dry season. These loads may only be achievable by firing fuel oil, thus reducing the benefits of the CWM fuel conversions.

Philippines

The potential for CWM fuel use in the Philippines was studied extensively in a recent AID study entitled "Introducing Coal-Water-Mix Fuels to the Philippines." Experimental work on indigenous coal and detailed financial analysis showed that there would be substantial benefit in converting the 850 MW oil fired Sucat Station to CWM fuel firing.

Thailand

Thailand's power generation is handled by the Electricity Generating Authority of Thailand (EGAT). EGAT is highly dependent on oil firing. Over 60% of the Electricity generation is from oil firing and the oil fired capacity factor is 70%. EGAT is undertaking to increase the use of its hydropower and lignite resources in new generating facilities. Although the indigenous coal is probably unsuitable for CWM fuel preparation, imported fuel may have some potential in Thailand.

4.2.3 CWM Fuel Potential - Asia

There are five possible candidates for CWM fuel use in this region: Indonesia, India, Pakistan, Philippines and Thailand. The total potential for oil displacement in these five countries is estimated at about 6,500,000 tonnes of oil equivalent per year.

4.3 Latin America

4.3.1 Regional Overview

The twenty countries under consideration in the Latin America region are located in Central America, South America and the Caribbean. They show a very wide variation in level of industrialization, climate, geography and energy resources. Therefore, the level of CWM potential and its nature will vary substantially from country to country.

Nearly all of the countries in the region have indigenous coal resources or access to coal imports. Table 4-1 shows the coal resources in the region. The majority of the recoverable coal in the region is located in four countries: Brazil, Chile, Colombia, and Mexico. Smaller resources are found in Argentina, Peru and Venezuela. About 30% of the coal used in this region in 1982 was imported, primarily from the United States, Canada and Poland.

4.3.2 Electric Utilities - Latin America

Half of the countries in this region can be eliminated from consideration for CWM fuel because of their low level of fuel oil fired electricity generating capacity. These countries are Barbados, Belize, Bolivia, Costa Rica, El Salvador, Guatemala, Guyana, Haiti, Honduras and Paraguay. It is conceivable, however, that these countries could be included in a regional CWM fuel use strategy.

TABLE 4-1

COAL RESOURCES - LATIN AMERICA

	<u>Recoverable Reserves (10⁶t)</u>	<u>1981 Production (10⁶tpy)</u>	<u>1981 Net Imports (10⁶tpy)</u>	<u>1981 Consumption (10⁶tpy)</u>
<u>AID Affiliated</u>				
Argentina	N/A	0.5	0.8	1.3
Brazil	1118	5.7	4.2	9.9
Colombia	1036	5.0	-0.2	4.8
Mexico	1591	8.1	0.2	8.3
Peru	N/A	0.05	0.03	0.08
<u>Non-Affiliated</u>				
Chile	1182	1.0	0.2	1.2
Venezuela	N/A	0.05	0.03	0.08

Sources: United Nations - 1982 Energy Statistics Yearbook
 U.S.D.O.E. - 1982 International Energy Annual

N/A: Not Available

The electric utility situation in each country is discussed below with an emphasis on its potential for CWM fuel use. A regional summary is given in the next subsection.

Costa Rica

All of the electricity in Costa Rica is generated from hydroelectric units. Sufficient capacity exists for the country to be an exporter of electricity. There is apparently one steam plant in the system, but this is generally not in use. Coal exploration has begun in the southern part of the country. This coal could be used in a regional CWM strategy by producing the fuel in Costa Rica and exporting it to user countries in the region.

Dominican Republic

Nearly half of the electric power in the Dominican Republic is generated in oil-fired thermal units (see Table A-4). The country has recently undertaken to increase its use of coal by starting operation of the new coal-fired Itabo Station. Fuel oil is still being burned at Rio Haina, Puerto Plata, and elsewhere. The Dominican Republic has no indigenous coal resources but has established a coal importation infrastructure. Therefore, it may be a potential candidate for the use of imported CWM fuel or as a central preparation site.

Ecuador

Ecuador also has substantial oil fired generating capacity. About 40% of its total utility capacity is oil fired, the remainder is almost entirely hydroelectric. Although it has a modest recoverable reserve of sub-bituminous coal, the country has not yet undertaken to exploit this resource. In addition, Ecuador's present importation of coal is quite small.

Jamaica

Jamaica is very heavily dependent on imported oil for its power generation. Over 70% of its installed capacity and over 80% of its electricity generation is oil based. Although it has no coal resources, Jamaica has considered the conversion of two of its oil-fired plants, Old Harbour and Hunts Bay, to coal firing. Conversion of these plants to CWM fuel would require importation of coal or CWM fuel.

Panama

Panama's electricity generating capacity is a combination of oil fired stations and hydroelectric facilities. There is no evidence of coal firing in the country at this time and Panama has no explored coal resources, but recent work indicates that coal may exist in a deposit which may extend into the country from Costa Rica.

Peru

Peru's electricity generation is also based on hydropower along with gas and oil firing. The oil fired capacity represents about 20% of the total installed

capacity and about 10% of the total power. Peru has a small reserve of bituminous and anthracite coal. Two deposits have been developed and are being used domestically. Peru's relatively small oil fired capacity and its substantial hydropower potential could make the incentive for CWM fuel use small.

Argentina

Argentina is second to Mexico in the size of its oil fired electricity generating capacity. The country has substantial sub-bituminous coal, oil, and natural gas reserves. The Argentine government recently announced a plan to accelerate the exploitation of their indigenous natural gas resources. In 1982, Argentina was a net exporter of oil and natural gas but a net importer of coal. Therefore, since it is a net energy exporter but a coal importer, the incentives for CWM fuel use in Argentina are likely to be small.

Brazil

Brazil's power generation is dominated by hydro-electric capability which accounted for over 90% of the total generation in 1982. Only about 1% of both the total generation and the total installed capacity is oil-fired. Brazil's coal reserves are concentrated in the southern part of the country and their quality may be inappropriate for CWM formulation. Overall, the potential for the displacement of imported oil with indigenous CWM appears to be small for Brazil's electric utility sector. Programs are underway to evaluate using indigenous renewable resources such as sugar cane and wood as oil substitutes.

Colombia

Only 4% of Colombia's electric utility generating capacity is oil fired. Nearly 90% is either coal fired or hydro-electric. Colombia is presently a net importer of coal, but exploration work is underway to expand production of the indigenous bituminous and sub-bituminous coal reserves. This expansion is likely to make Colombia a major coal exporter in the near future. This coal may be suitable for CWM fuel formulation which could make Colombia a major CWM fuel user and exporter.

Mexico

Mexico presently generates more than half of its electricity with oil. In 1981, Mexico was a net importer of coal and a major exporter of fuel oil. The majority of Mexico's coal reserves are located in the northern region of the country. Present coal production is dedicated to metallurgical uses and existing coal fired power plants. However, an increase in world oil prices would be an incentive for increased exports of fuel oil and use of indigenous coal or even importation of coal or CWM fuel.

4.3.3 CWM Fuel Potential - Latin America

The Latin America region shows great diversity in energy use patterns, levels of industrialization and natural resources. The maximum CWM fuel use potential in this region was calculated to be nearly 12,000,000 tonnes of oil equivalent per year. This oil displacement would reduce the region's dependence on oil firing

from 20% of the total generation to 10%. However, the size and diversity of the region requires that certain observations be made.

The four largest countries in the region, Argentina, Brazil, Colombia and Mexico, account for over 80% of the total projected CWM fuel use. There are substantial uncertainties in the acceptance potential of CWM fuel in these countries. Since Argentina and Mexico are net oil exporters, the foreign exchange impact of oil substitution is not as important to them. Brazil has such a small oil-fired capacity that the incentives for CWM fuel potential are likely to be small. Colombia may have the strongest interest in CWM fuel in the role of a fuel exporter as well as a user.

The Caribbean nations of Jamaica and the Dominican Republic along with Panama and Ecuador may have potential as users of imported CWM fuel. Therefore, a regional strategy based on CWM fuel preparation in Colombia, the United States, or possibly Costa Rica could have potential. Such a strategy would require international cooperation in planning and implementation. However, since the most promising markets in this region would rely on imported fuel (coal or CWM fuel) a centralized preparation facility could prove to be an economic alternative for this region.

4.4 Near East

4.4.1 Regional Overview

Although this region, as a whole, has a large petroleum resource, four of the AID client countries, Jordan, Lebanon, Morocco, and Yemen, are net importers of oil. These countries may be able to derive some foreign exchange benefit from CWM fuel use.

The coal reserves in the region are concentrated in Egypt and Morocco. Egypt has not completely exploited this energy resource. Morocco's anthracite reserves have been under development for many years and have made the country one of the few coal exporters on the African continent.

The increasing industrialization of the countries in this region has produced rapid electricity demand growth. However, non-commercial fuels are still used to some extent in this region.

4.4.2 Electric Utilities - Near East

As indicated on Table A-4, all of the countries in this region have some oil-fired capacity. The primary candidates for CWM fuel usage, Egypt, Lebanon, Morocco, Tunisia and Yemen are discussed below. The other three countries were eliminated from considerations for the following reasons. It appears that coal or CWM fuel delivery to Jordan could be impractical. Oman was eliminated due to the fact that the only oil fired plant in the country is owned by an oil refining company making CWM fuel penetration unlikely. It appears that all of Syria's capacity consists of diesel generators and gas turbines.

Egypt

The Egyptian Electricity Authority provides all of the electricity generation and distribution in the country. Over half of the installed capacity in the country is from the two hydroelectric facilities at the Aswan Dam. Half of the thermal capacity is in oil-fired units. Electricity is also produced in gas-fired and coal-fired plants. The oil-fired plants, as a group, have a very high capacity factor which may limit the applicability of CWM fuel. Present construction plans encompass about 20,000 MW of oil-, gas-, and coal-fired plants, hydroelectric facilities and nuclear plants.

Lebanon

Electricite du Liban generates and delivers about 90% of the electricity in Lebanon. About 60% of their capacity is oil-fired. Further information is required on the present status of the power infrastructure to accurately determine the potential for CWM fuel. However, the present social/political situation makes the introduction of CWM fuel in Lebanon in the near future impractical to consider.

Morocco

Over 90% of the electricity generation in Morocco is supplied by the Office Nationale de l'Electricite. About a third of the generating capacity is oil fired. Another third is supplied by the Jerada coal-fired plant. Morocco's coal reserves consist primarily of anthracite which is probably unsuitable for CWM fuel production. However, the existing coal infrastructure could be used for the preparation and handling of CWM fuel made from imported coal.

Tunisia

Tunisia's nationalized power company is known as the Societe Tunisienne de l'Electricite et du Gaz. About 60% of the installed capacity is oil fired and has a relatively low capacity factor. This indicates that Tunisia may be a candidate for CWM fuel use. However, the fuel would have to be made from an imported fuel.

Yemen

Over half of Yemen's installed capacity is represented by the 150 MW oil-fired plant at Ras Katenib, the rest is produced by diesel generators. This plant only went into operation in 1983 and information on its power generation was not available.

4.4.3 CWM Fuel Potential - Near East

Egypt, Morocco, and Tunisia all appear to be relatively good candidates for CWM fuel use. The CWM fuel potential in this region is estimated to be 1,900,000 tonnes of oil equivalent. Egypt has indigenous coal which may be suitable for CWM fuel; Morocco and Tunisia do not. Egypt and Tunisia are net exporters of petroleum. Further information is required to determine the potential for CWM fuel in Yemen.

5.0 SUMMARY AND RECOMMENDATIONS

The purpose of this study was to assess the potential for using CWM fuel as a replacement for fuel oil in AID client countries. The investigation was limited to steam electric power plants firing oil. Industrial uses of fuel oil were not included.

A total of four countries were identified as particularly good candidates for CWM fuel use: Indonesia, Philippines, Egypt, and Colombia. These countries were found to be the best candidates on the basis of their present fuel oil firing and their indigenous coal resources. The presence of suitable coal within the country was considered important because of the foreign exchange benefits that would accrue from substituting a domestic fuel (coal) for a fuel that is either imported or of export quality (oil).

Twelve other countries were identified as potential users of CWM fuel. These countries are: Argentina, Brazil, Dominican Republic, India, Ivory Coast, Jamaica, Mexico, Morocco, Pakistan, Thailand, Tunisia and Senegal.

These countries were not considered to be outstanding candidates for a variety of reasons. In some cases, the fuel oil fired capacity in the country was a small fraction of the total capacity but still a large number in absolute terms. For example, only 1% of Brazil's electricity is generated from fuel oil but this amounts to about 400 MW. Substantial savings could accrue from converting 400 MW of capacity but this would have minimal effect on the country's overall energy picture. For most countries in this class, although they have potential for CWM fuel use they do not have sufficient or suitable coal reserves for CWM fuel preparation. They would be in the position to substitute one imported fuel for a less expensive imported fuel, which could provide to be an economic option.

It is recommended that all 16 of these countries be studied further. A more detailed look at their present and projected generating capabilities and demands would be required. In addition, the individual oil fired plants in each country would have to be investigated for their suitability for CWM fuel firing. The fuel supply question for these countries should be addressed in two ways: individually and regionally. In the countries that have CWM fuel potential as well as coal resources, experimental work may be required to determine the suitability of their coals for CWM fuel formulation. In addition, the size of the coal reserves must be accurately assessed to ensure the long term supply of CWM fuel.

Regional strategies for CWM fuel use would involve CWM fuel preparation in one country and shipment of the prepared fuel to other users in the region. This would increase the cost of the fuel and have lower economic benefits than using domestic fuel. The preparation site could be in the country with the coal resource or in one of the user countries that lack domestic coal. This strategy should be particularly investigated for the countries in the Caribbean area (specifically Dominican Republic and Jamaica) and western Africa (Ivory Coast and Senegal).

A total of 69 countries were studied for their potential for CWM fuel firing. Four countries were identified as particularly good candidates. Twelve others

were identified as potential candidates that would derive lesser benefits from CWM fuel use. The total potential annual fuel oil displacement was calculated to be about 20 million tonnes of oil per year. This is equivalent to about 140 million barrels or about \$4 billion at current oil prices. Increased oil prices could increase the economic attractiveness and strategic incentives for CWM fuel use to an even higher level.

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TABLE A-1 - GENERAL ECONOMIC DATA

Name of Region, Country	Population (million)	Annual GDP (US\$ million)	Annual GDP per Capita (1981 US\$)	Commerical Energy Consumed		Electricity Consumption		
				Total (mtoe)	per Capita (kgoe)	Total (Gwh)	per Capita (Kwh)	Share of Energy (%)
AFRICA								
Benin	3.64	1,140	313	0.125	34	88	24	18
Botswana	0.93	949	1,021	0.372	400	401	431	27
Burundi	4.23	1,117	264	0.066	16	51	12	19
Cameroon	8.67	7,225	834	0.799	92	1,670	193	52
Cape Verde	0.30	65	218	0.034	113	9	30	7
Djibonti	0.38	-	-	0.049	129	110	289	56
The Gambia	0.61	211	349	0.052	86	44	73	21
Ghana	11.83	27,875	2,356	1.902	161	5,400	456	65
Guinea	5.57	1,684	302	0.300	54	498	89	42
Guinea-Bissau	0.79	132	167	0.029	37	30	38	26
Ivory Coast	8.51	8,666	1,019	1.154	136	1,843	217	40
Kenya	17.36	6,715	387	2.166	125	1,949	112	22
Lesotho	1.37	400	291	0.133	97	96	71	18
Liberia	1.94	1,055	544	0.559	288	1,109	571	50
Malawi	6.24	1,299	208	0.267	43	425	68	40

Notes: Population - Mid-Year Estimates for 1981
 GPD - Gross Domestic Products - Market Prices in 1981 US\$
 mtoe - Million tonnes of oil equivalent
 kgoe - Kiloqrams of oil equivalent

TABLE A-1 - GENERAL ECONOMIC DATA
(Continued)

Name of Region, Country	Population (million)	Annual GDP (US\$ million)	Annual GDP per Capita (1981 US\$)	Commerical Energy Consumed		Electricity Consumption		
				Total (mtoe)	per Capita (kgoe)	Total (Gwh)	per Capita (Kwh)	Share of Energy (%)
AFRICA								
Mali	6.88	1,110	161	0.146	21	91	13	16
Mauritania	1.56	703	451	0.195	125	126	81	16
Niger	5.70	1,711	300	0.161	28	298	52	46
Rwanda	5.35	1,258	235	0.062	12	105	20	44
Senegal	5.86	2,537	433	0.780	133	725	124	23
Sierre Leone	3.57	1,154	323	0.216	60	232	65	27
Somalia	4.39	1,849	421	0.312	71	110	25	9
Sudan	19.24	10,153	528	1.322	69	1,303	68	25
Swaziland	0.64	653	1,018	N/A	N/A	497	775	N/A
Tanzania	18.60	5,232	281	0.759	41	954	51	31
Togo	2.66	883	332	0.268	101	254	95	24
Uganda	13.05	10,327	792	0.266	20	338	26	32
Upper Volta	6.33	1,175	186	0.137	22	115	18	21
Zaire	29.78	5,384	181	2.046	69	4,278	144	52
Zambia	5.84	3,486	597	2.525	432	6,040	1,034	60
Zimbabwe	7.19	6,550	911	4.025	560	7,332	1,020	46
Africa Totals and Averages	209.01	113,080	541	21.227	102	36,522	175	43

TABLE A-1 - GENERAL ECONOMIC DATA
(Continued)

Name of Region, Country	Population (million)	Annual GDP (US\$ million)	Annual GDP per Capita (1981 US\$)	Commerical Energy Consumed		Electricity Consumption		
				Total (mtoe)	per Capita (kgoe)	Total (Gwh)	per Capita (Kwh)	Share of Energy (%)
<u>ASIA</u>								
Bangladesh	89.52	11,993	134	2.955	33	2,912	33	25
Burma	34.11	5,737	168	1.714	50	1,515	44	22
Fiji	0.65	1,267	1,962	0.275	426	317	491	29
India	690.18	165,024	239	102.34	148	131,745	191	32
Indonesia	149.66	77,986	521	25.42	170	10,988	73	11
Nepal	15.03	2,423	161	0.147	10	282	19	48
Pakistan	84.50	28,245	334	14.360	167	16,068	190	30
Philippines	50.35	36,746	730	13.170	260	19,647	390	37
Sri Lanka	14.99	4,417	295	1.354	90	1,860	124	34
Thailand	47.50	36,031	759	11.320	238	16,872	355	37
Asia Totals and Averages	1,176.49	369,869	314	173.055	147	202,205	172	29

TABLE A-1 - GENERAL ECONOMIC DATA
(Continued)

Name of Region, Country	Population (million)	Annual GDP (US\$ million)	Annual GDP per Capita (1981 US\$)	Commerical Energy Consumed		Electricity Consumption		
				Total (mtoe)	per Capita (kgoe)	Total (Gwh)	per Capita (Kwh)	Share of Energy (%)
<u>LATIN AMERICA</u>								
Argentina	28.17	124,104	4,405	36.085	1,281	40,674	1,444	28
Barbados	0.25	925	3,693	0.200	800	349	1,396	44
Belize	0.15	165	1,108	0.061	409	83	557	34
Bolivia	5.72	7,164	1,252	1.693	296	1,675	293	25
Brazil	120.51	283,926	2,356	84.451	701	140,586	1,167	42
Costa Rica	2.34	2,627	1,123	1.275	559	2,295	1,009	45
Colombia	26.43	37,325	1,412	17.030	645	23,048	873	34
Dominican Rep.	5.59	7,226	1,292	1.861	332	3,928	702	53
Ecuador	8.61	13,879	1,613	3.926	457	3,771	438	24
El Salvador	4.67	3,545	759	0.954	203	1,565	333	41
Guatemala	7.48	8,663	1,159	1.460	195	1,668	233	29
Guyana	0.80	609	766	0.531	664	500	625	24
Haiti	5.10	1,517	297	0.276	54	374	73	33
Honduras	3.82	2,632	689	0.729	191	951	250	33

TABLE A-1 - GENERAL ECONOMIC DATA
(Continued)

Name of Region, Country	Population (million)	Annual GDP (US\$ million)	Annual GDP per Capita (1981 US\$)	Commerical Energy Consumed		Electricity Consumption		
				Total (mtoe)	per Capita (kgoe)	Total (Gwh)	per Capita (Kwh)	Share of Energy (%)
<u>LATIN AMERICA</u>								
Jamaica	2.19	2,939	1,340	2.515	1,146	2,091	953	21
Mexico	71.22	239,624	3,365	88.850	1,243	68,161	619	29
Nicaragua	2.78	2,582	930	0.696	251	1,190	429	43
Panama	1.88	3,840	2,046	1.456	776	3,361	1,790	58
Paraguay	3.06	5,625	1,840	0.428	140	842	275	49
Peru	17.03	23,257	1,366	8.975	527	10,547	619	29
Latin America Totals and Averages	317.80	772,174	2,430	253.452	798	307,667	968	30

TABLE A-1 - GENERAL ECONOMIC DATA
(Continued)

Name of Region, Country	Population (million)	Annual GDP (US\$ million)	Annual GDP per Capita (1981 US\$)	Commerical Energy Consumed		Electricity Consumption		
				Total (mtoe)	per Capita (kgoe)	Total (Gwh)	per Capita (Kwh)	Share of Energy (%)
<u>NEAR EAST</u>								
Egypt	43.29	25,296	584	16.851	389	23,788	549	35
Jordan	3.37	3,700	1,098	1.713	508	1,237	367	18
Lebanon	3.18	1,570	494	2,106	662	1,856	700	22
Morocco	20.89	14,836	710	4.948	237	5,613	269	28
Oman	0.95	5,200	5,474	0.896	943	1,148	1,117	32
Syria	9.31	15,239	1,636	5.794	622	3,920	421	17
Tunisia	6.53	8,279	1,268	2.97	455	3,020	463	25
Yeman	7.25	2,858	394	0.391	54	570	92	43
Near East Totals and Averages	94.77	76,978	812	35.669	376	41,252	435	29

TABLE A-2 - 1982 CONSUMPTION OF ENERGY-PETROLEUM PRODUCTS
(thousand metric tonnes)

Name of Region, Country	Residual Oil	Diesel Fuel	All Others	Total Energy Petroleum Products
<u>AFRICA</u>				
Benin	8	35	47	90
Botswana	N/A	N/A	N/A	N/A
Burundi	3	15	16	34
Cameroon	1,060	649	1,086	2,795
Cape Verde	6	23	10	39
Djibouti	28	10	31	69
Gambia	-0-	25	27	52
Ghana	50	211	378	639
Guinea	174	45	68	287
Guiner-Bissau	-0-	16	13	29
Ivory Cost	230	928	479	1,637
Kenya	408	331	372	1,111
Lesotha	N/A	N/A	N/A	N/A
Liberia	300	124	84	508
Malawi	1	80	58	139
Mali	23	46	70	139
Mauritania	36	122	39	197
Niger	6	120	55	181
Rwanda	3	17	43	63
Senegal	371	262	148	781
Sierre Leone	132	48	36	216
Somalia	6	228	124	358
Sudan	264	557	303	1,124
Swaziland	N/A	N/A	N/A	N/A
Tanzania	182	220	171	573
Togo	116	185	57	358
Uganda	34	55	108	197
Upper Volta	18	51	70	139
Zaire	185	390	305	880
Zambia	150	300	181	631
Zimbabwe	1	420	213	634
TOTAL	3,795	5,513	4,592	13,900

Source: United Nations, 1982 Energy Statistics Yearbook

TABLE A-2 - 1982 CONSUMPTION OF ENERGY-PETROLEUM PRODUCTS
 (thousand metric tonnes)
 (Continued)

Name of Region, Country	Residual Oil	Diesel Fuel	All Others	Total Energy Petroleum Products
<u>ASIA</u>				
Bangladesh	430	408	563	1,401
Burma	250	375	364	989
Fiji	8	190	85	283
India	7,131	12,821	8,482	28,434
Indonesia	6,262	5,235	8,962	20,459
Nepal	-0-	45	42	87
Pakistan	548	2,201	1,594	4,343
Philippines	4,244	3,701	2,204	10,149
Sri Lanka	296	500	322	1,118
Thailand	<u>3,840</u>	<u>3,250</u>	<u>3,093</u>	<u>10,183</u>
TOTAL	23,009	28,726	25,711	77,443

TABLE A-2 - 1982 CONSUMPTION OF ENERGY-PETROLEUM PRODUCTS
(thousand metric tonnes)
(Continued)

Name of Region, Country	Residual Oil	Diesel Fuel	All Others	Total Energy Petroleum Products
<u>Latin America</u>				
Barbados	85	45	69	199
Belize	3	25	28	56
Bolivia	140	228	727	1,095
Costa Rico	170	340	204	714
Dominican Rep.	746	438	405	1,589
Ecuador	1,150	962	1,862	3,974
El Salvador	160	210	231	601
Guatemala	340	330	380	1,050
Guyana	285	165	79	529
Haiti	55	85	62	202
Honduras	130	255	183	568
Jamaica	1,845	200	319	2,364
Nicaragua	160	160	196	516
Panama	340	250	304	894
Paraguay	56	276	141	473
Peru	<u>2,100</u>	<u>1,470</u>	<u>2,534</u>	<u>6,104</u>
SUBTOTAL	7,765	5,439	7,724	20,928
Argentina	4,598	6,954	7,937	19,489
Brazil	13,923	15,648	12,836	42,416
Colombia	704	1,329	5,226	7,250
Mexico	<u>17,235</u>	<u>11,710</u>	<u>24,223</u>	<u>53,168</u>
SUBTOTAL	36,460	35,641	50,222	122,323
TOTAL	44,225	41,080	57,946	143,251

TABLE A-2 - 1982 CONSUMPTION OF ENERGY-PETROLEUM PRODUCTS
(thousand metric tonnes)
(Continued)

Name of Region, Country	Residual Oil	Diesel Fuel	All Others	Total Energy Petroleum Products
<u>Near East.</u>				
Egypt	7,486	3,000	3,660	14,146
Jordan	704	668	548	1,920
Lebanon	552	250	295	1,097
Morocco	1,770	1,220	679	3,669
Oman	3	260	236	499
Syria	2,593	2,530	1,091	6,214
Tunisia	882	906	508	2,296
Yeman	60	250	196	506
TOTAL	14,050	9,084	7,213	30,347

TABLE A-3 - COAL RESOURCES, RESERVES AND ANNUAL PRODUCTION
(million metric tonnes)

NAME OF REGION COUNTRY	RESERVES IN PLACE				RECOVERABLE RESERVES				ADDITIONAL RESOURCES				RECENT ANNUAL PRODUCTION OF HARD COAL
	ANTR BIT	SUBIT LIG.	PEAT	TOTAL	ANTR BIT	SUBIT LIG.	PEAT	TOTAL	ANTR BIT	SUBIT LIG.	PEAT	TOTAL	
<u>AFRICA</u>													
BenIn	-	-	-	-	-	-	-	-	-	-	-	-	-
Botswana	7,000	-	-	7,000	3,500	-	-	3,500	100,000	-	-	100,000	
Burundi	-	-	-	-	-	-	-	-	-	-	500	500	
Cameroon	-	-	-	-	-	-	-	-	-	-	-	-	
Cape Verde	-	-	-	-	-	-	-	-	-	-	-	-	
Ojibouti	-	-	-	-	-	-	-	-	-	-	-	-	
Gambia	-	-	-	-	-	-	-	-	-	-	-	-	
Ghana	-	-	-	-	-	-	-	-	-	-	-	-	
Guinea	-	-	-	-	-	-	-	-	-	-	-	-	
Guinea- Bissau	-	-	-	-	-	-	-	-	-	-	-	-	
Ivory Coast	-	-	-	-	-	-	-	-	-	-	-	-	
Kenya	-	-	-	-	-	-	-	-	-	-	-	-	
Lesotho	-	-	-	-	-	-	-	-	-	-	-	-	
Liberia	-	-	-	-	-	-	-	-	-	-	-	-	

TABLE A-3 - COAL RESOURCES, RESERVES AND ANNUAL PRODUCTION
(million metric tonnes)
(Continued)

NAME OF REGION COUNTRY	RESERVES IN PLACE				RECOVERABLE RESERVES					ADDITIONAL RESOURCES				RECENT ANNUAL PRODUCTION OF HARD COAL		
	ANTR	SUBIT	LIG.	PEAT	TOTAL	ANTR	SUBIT	LIG.	PEAT	TOTAL	ANTR	SUBIT	LIG.		PEAT	TOTAL
	BIT					BIT					BIT					
Malawi	25	-	-	-	25	12	-	-	-	12	-	-	-	-	-	-
Mali	-	-	-	-	-	-	-	-	-	-	3	-	-	3	-	-
Mauritania	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Niger	5	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-
Rwanda	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Senegal	-	-	-	-	-	-	-	-	-	-	-	-	-	2,000	2,000	-
Sierra Leone	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Somalia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sudan	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Swaziland	2,020	-	-	-	2,020	1,820	-	-	-	1,820	3,000	-	-	-	3,000	-
Tanzania	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Togo	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Uganda	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Upper Volta	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zaire	-	-	-	-	-	-	-	-	-	6,000	-	-	-	-	-	-
Zambia	-	-	-	-	-	-	-	-	-	24	-	-	-	-	-	-
Zimbabwe	-	-	-	-	-	-	-	-	-	734	-	-	-	-	-	2.8

TABLE A-3 - COAL RESOURCES, RESERVES AND ANNUAL PRODUCTION
(million metric tonnes)
(Continued)

NAME OF REGION COUNTRY	RESERVES IN PLACE				RECOVERABLE RESERVES				ADDITIONAL RESOURCES				RECENT ANNUAL PRODUCTION OF HARD COAL (1982)
	ANTR BIT	SUBIT LIG.	PEAT	TOTAL	ANTR BIT	SUBIT LIG.	PEAT	TOTAL	ANTR BIT	SUBIT LIG.	PEAT	TOTAL	
<u>ASIA</u>													
Bangladesh	1,054	-	138	1,192	-	-	-	-	-	-	138	138	--
Burma	5	-	-	5	2	-	-	2	120	80	-	200	0.038
FIJI	-	-	-	-	-	-	-	-	-	-	-	-	-
India	26,331	1,581	-	27,912	-	1,581	-	1,581	85,547	1,943	-	87,490	128.320
Indonesia	102	591	-	693	-	-	-	-	477	15,445	-	15,922	0.481
Nepal	-	-	-	-	-	-	-	-	-	-	-	-	-
Pakistan	-	145	-	145	-	102	-	102	-	310	-	310	1.765
Philippines	-	170	-	170	-	82	-	82	-	-	-	-	0.558
Sri Lanka	-	-	-	-	-	-	-	-	-	-	51	51	--
Thailand	-	15	-	15	-	471	-	471	-	1,418	-	1,418	0.002

TABLE A-3 - COAL RESOURCES, RESERVES AND ANNUAL PRODUCTION
(million metric tonnes)
(Continued)

NAME OF REGION COUNTRY	RESERVES IN PLACE				RECOVERABLE RESERVES				ADDITIONAL RESOURCES				RECENT ANNUAL PRODUCTION OF HARD COAL (1982)
	ANTR BIT	SUBIT LIG.	PEAT	TOTAL	ANTR BIT	SUBIT LIG.	PEAT	TOTAL	ANTR BIT	SUBIT LIG.	PEAT	TOTAL	
<u>LATIN AMERICA</u>													
Argentina	-	195	-	195	-	130	80	210	-	7,735	-	7,735	0,515
Barbados	-	-	-	-	-	-	-	-	-	-	-	-	-
Belize	-	-	-	-	-	-	-	-	-	-	-	-	-
Bolivia	-	-	-	-	-	-	-	-	-	-	-	-	-
Brazil	-	23,000	25,000	48,000	-	13,000	8,000	21,000	-	-	-	-	6,400
Costa Rica	-	*	-	*	-	-	-	-	-	-	-	-	-
Colombia	2,025	48	-	2,073	1,010	25	-	1,035	7,200	790	-	7,990	5,550
Dominican Rep.	-	-	-	-	-	-	-	-	-	-	-	-	-
Ecuador	-	-	-	-	-	18	-	18	-	6	-	6	-
El Salvador	-	-	-	-	-	-	-	-	-	-	-	-	-
Guatemala	-	-	-	-	-	-	-	-	-	-	-	-	-
Guyana	-	-	-	-	-	-	-	-	-	-	-	-	-
Haiti	-	13	-	13	-	-	-	-	-	27	-	27	-

*Under explorations

TABLE A-3 - COAL RESOURCES, RESERVES AND ANNUAL PRODUCTION
(million metric tonnes)
(Continued)

NAME OF REGION COUNTRY	RESERVES IN PLACE				RECOVERABLE RESERVES				ADDITIONAL RESOURCES				RECENT ANNUAL PRODUCTION OF HARD COAL (1982)
	ANTR BIT	SUBIT LIG.	PEAT	TOTAL	ANTR BIT	SUBIT LIG.	PEAT	TOTAL	ANTR BIT	SUBIT LIG.	PEAT	TOTAL	
Honduras	-	21	-	21	-	-	-	-	-	-	-	-	-
Jamaica	-	-	-	-	-	-	-	-	-	-	-	-	-
Mexico	1,623	620	-	2,243	1,295	496	-	1,791	1,960	400	-	2,360	8,200
Nicaragua	-	-	-	-	-	-	-	-	-	-	-	-	-
Panama	-	*	-	*	-	-	-	-	-	-	-	-	-
Paraguay	-	-	-	-	-	-	-	-	-	-	-	-	-
Peru	28	-	-	28	-	-	-	-	856	-	-	856	0,055

* Under exploration

TABLE A-3 - COAL RESOURCES, RESERVES AND ANNUAL PRODUCTION
 (million metric tonnes)
 (Continued)

NAME OF REGION COUNTRY	RESERVES IN PLACE				RECOVERABLE RESERVES				ADDITIONAL RESOURCES				RECENT ANNUAL PRODUCTION OF HARD COAL (1982)
	ANTR BIT	SUBIT LIG.	PEAT	TOTAL	ANTR BIT	SUBIT LIG.	PEAT	TOTAL	ANTR BIT	SUBIT LIG.	PEAT	TOTAL	
<u>NEAR EAST</u>													
Egypt	25	-	-	25	13	-	-	13	-	-	-	-	0.730
Jordan	-	-	-	-	-	-	-	-	-	-	-	-	
Lebanon	-	-	-	-	-	-	-	-	-	-	-	-	
Morocco	134	44	-	178	45	-	-	45	-	-	-	-	
Oman	-	-	-	-	-	-	-	-	-	-	-	-	
Syria	-	-	-	-	-	-	-	-	-	-	-	-	
Tunisia	-	-	-	-	-	-	-	-	-	-	-	-	
Yemen	-	-	-	-	-	-	-	-	-	-	-	-	

TABLE A-4 - ELECTRIC UTILITIES GENERATING CAPACITY AND ENERGY PRODUCTION

Name of Region Country	Installed Capacity		Annual Energy Generation		Average Capacity Factor Oil
	Total (MW)	Oil (MW)	Total (GWh)	Oil (GWh)	
<u>AFRICA</u>					
Benin	21	-	8	-	-
Botswana	90	-	400	-	-
Burundi	20	-	51	-	-
Cameroon	348	-	1,670	-	-
Cape Verde	6	-	9	-	-
Djibonti	35	-	110	-	-
The Gambia	8	-	44	-	-
Ghana	996	-	5,400	-	-
Guinea	102	-	498	-	-
Guinea-Bissau	20	-	30	-	-
Ivory Coast	891	214	1,843		-
Kenya	596	98	1,949	300	29
Lesotho	1	-	3	-	-
Liberia	360	-	1,109	-	-
Malawi	171	-	423	-	-

Notes: "Oil" does not include diesels or gas turbines.
Generation does not include imports and exports of power.

TABLE A-4 - ELECTRIC UTILITIES GENERATING CAPACITY AND ENERGY PRODUCTION
(Continued)

Name of Region Country	Installed Capacity		Annual Energy Generation		Average Capacity Factor Oil
	Total (MW)	Oil (MW)	Total (GWh)	Oil (GWh)	
<u>AFRICA</u>					
Mali	83	-	91	-	-
Mauritania	84	-	126	-	-
Niger	70	-	298	-	-
Rwanda	29	-	106	-	-
Senegal	205	170	725	689	46
Sierre Leone	98	-	232	-	-
Somalia	90	-	110	-	-
Sudan	311	55	1,303	205	43
Swaziland	70	-	269	-	-
Tanzania	372	-	955	-	-
Togo	98	-	84	-	-
Uganda	185	-	696	-	-
Upper Volta	35	-	115	-	-
Zaire	1,144	-	4,278	-	-
Zambia	1,395	-	9,117	-	-
Zimbabwe	1,668	-	7,332	-	-

TABLE A-4 - ELECTRIC UTILITIES GENERATING CAPACITY AND ENERGY PRODUCTION
(Continued)

Name of Region Country	Installed Capacity			Annual Energy Generation			Average Capacity Factor Oil
	Total (MW)	Oil (MW)	%	Total (GWh)	Oil (GWh)	%	
<u>ASIA</u>							
Bangladesh	987	80	8.1	2,912	248	8.5	35
Burma	636	99	15.6	1,515	136	9.0	7
Fiji	114	0	0	317	0	0	0
India	35,384	510	1.4	131,745	1,872	1.4	42
Indonesia	3031	1156	38.2	10,988	5,516	50.2	55
Nepal	138	0	0	282	0	0	-
Pakistan	4,098	964	23.5	16,068	-	-	-
Philippines	4,769	2,375	49.8	19,647	10,177	51.8	49
Sri Lanka	499	50	10.0	1,860	200	10.8	46
Thailand	4,632	1643	35	16,872	10,280	60.9	72

TABLE A-4 - ELECTRIC UTILITIES GENERATING CAPACITY AND ENERGY PRODUCTION
(Continued)

Name of Region Country	Installed Capacity			Annual Energy Generation			Average Capacity Factor Oil
	Total (MW)	Oil (MW)	%	Total (GWh)	Oil (GWh)	%	
<u>LATIN AMERICA</u>							
Argentina	13,050	3,196	24.5	40,674	8,930	22	31.9
Barbados	95	34	36	349	228	65	76.6
Belize	41	-	-	83	-	-	-
Bolivia	500	-	-	1,675	-	-	-
Brazil	37,282	418	1.1	140,586	1,472	1.0	40.2
Costa Rica	652	45	7	2,295	124	5.4	31.5
Colombia	4,574	192	4.2	23,048	770	3.3	45.9
Dominican Rep.	1,159	520	44.8	3,929	2,489	63	54.6
Ecuador	1,264	500	39.5	3,771	1,529	40.5	34.9
El Salvador	502	95	18.9	1,565	102	6.5	12.3
Guatemala	533	145	27	2,668	1,065	40	83.8
Guyana	182	-	-	500	250	50	-
Haiti	138	-	-	374	-	-	-
Honduras	234	-	-	951	-	-	-

TABLE A-4 - ELECTRIC UTILITIES GENERATING CAPACITY AND ENERGY PRODUCTION
(Continued)

Name of Region Country	Installed Capacity		Annual Energy Generation		Average Capacity Factor Oil
	Total (MW)	Oil (MW)	Total (GWh)	Oil (GWh)	
<u>LATIN AMERICA</u>					
Jamaica	683	500	2,093	1,764	40
Mexico	19,479	9,091	68,161	37,650	47
Nicaragua	455	352	1,190	700	23
Panama	692	268	3,361	1,768	75
Paraguay	275	36	842	7	2
Peru	3,282	722	10,547	1,118	18

TABLE A-4 - ELECTRIC UTILITIES GENERATING CAPACITY AND ENERGY PRODUCTION
(Continued)

Name of Region Country	Installed Capacity		Annual Energy Generation		Average Capacity Factor Oil
	Total (MW)	Oil (MW)	Total (GWh)	Oil (GWh)	
<u>NEAR EAST</u>					
Egypt	4,514	1,350	23,788	8,656	73
Jordan	522	300	1,237	956	36
Lebanon	688	422	1,856	N/A	N/A
Morocco	1,752	500	5,613	2,353	54
Oman	390	45	N/A	N/A	N/A
Syria	1,762	0	3,920	0	-
Tunisia	931	560	3,020	1,580	32
Yemen	260	150	670	N/A	N/A

TABLE A-5 - BREAKDOWN OF COMMERCIAL ENERGY CONSUMPTION BY
ELECTRIC UTILITIES AND OTHER (1980 ESTIMATES)
GWh (Mtoe)

Name of Region Country	Electric Power						Other		
	Coal	Oil*	Hydro	Nucl.	Other	Total	Oil	Other	Total
AFRICA									
Benin	-								
Botswana	378 (0.095)	23 (0.006)	-	-	-	401 (0.1)	572 (0.143)	500 (0.125)	1,072 (0.268)
Burundi	-	5 (0.001)	-	-	46 (0.012)	51 (0.013)	129 (0.032)	82 (0.021)	211 (0.053)
Cameroon	-	109 (0.027)	1,561 (0.39)	-	-	1,670 (0.417)	1,436 (0.359)	87 (0.022)	1,523 (0.381)
Cape Verde	-	9 (0.002)	-	-	-	9 (0.002)	128 (0.032)	-	128 (0.032)
Djibouti	-	110 (0.028)	-	-	-	110 (0.028)	86 (0.022)	-	86 (0.022)
Gambia	-	44 (0.011)	-	-	-	44 (0.011)	164 (0.041)	-	164 (0.041)
Ghana	-	56 (0.014)	5,344 (1.336)	-	-	5,400 (1.35)	2,204 (0.551)	4 (0.001)	2,208 (0.552)
Guinea	-	418 (0.015)	80 (0.02)	-	-	498 (0.125)	700 (0.175)	-	700 (0.175)
Guinea-Bissau	-	30 (0.007)	-	-	-	30 (0.007)	84 (0.021)	-	84 (0.021)
Ivory Coast	-	184 (0.046)	1,659 (0.415)	-	-	1,843 (0.461)	2,772 (0.693)	-	2,772 (0.683)
Kenya	-	334 (0.084)	1,382 (0.345)	-	233 (0.058)	1,949 (0.487)	6,352 (1.588)	363 (0.091)	6,715 (1.679)
Lesotho	-	3 (0.001)	-	-	93 (0.023)	96 (0.024)	244 (0.061)	284 (0.071)	528 (0.132)
Liberia	-	821 (0.205)	288 (0.072)	-	-	1,109 (0.277)	1,128 (0.282)	-	1,128 (0.282)
Malawi	-	26 (0.006)	397 (0.099)	-	2 (0.001)	425 (0.106)	508 (0.127)	136 (0.034)	644 (0.161)

*Includes diesel and gas turbines.

TABLE A-5 - BREAKDOWN OF COMMERCIAL ENERGY CONSUMPTION BY
ELECTRIC UTILITIES AND OTHER (1980 ESTIMATES)
 GWh (Mtoe)
 (Continued)

Name of Region Country	Electric Power						Other		
	Coal	Oil	Hydro	Nucl.	Other	Total	Oil	Other	Total
AFRICA									
Mali	-	21 (0.005)	70 (0.017)	-	-	91 (0.023)	492 (0.123)	-	492 (0.123)
Mauritania	-	126 (0.032)	-	-	-	126 (0.032)	636 (0.159)	16 (0.004)	652 (0.163)
Niger	-	129 (0.032)	-	-	169 (0.042)	298 (0.075)	344 (0.086)	-	344 (0.086)
Rwanda	-	16 (0.004)	59 (0.015)	-	30 (0.007)	105 (0.026)	136 (0.034)	4 (0.001)	140 (0.035)
Senegal	-	725 (0.181)	-	-	-	725 (0.181)	2,396 (0.599)	-	2,396 (0.599)
Sierre Leone	-	222 (0.056)	10 (0.003)	-	-	232 (0.058)	630 (0.158)	-	630 (0.158)
Somalia	-	110 (0.028)	-	-	-	110 (0.028)	1,138 (0.285)	-	1,138 (0.285)
Sudan	-	571 (0.143)	732 (0.183)	-	-	1,303 (0.326)	3,868 (0.967)	120 (0.03)	3,988 (0.997)
Swaziland				-	227 (0.057)	497 (0.124)			
Tanzania	-	164 (0.041)	790 (0.197)	-	-	954 (0.239)	2,076 (0.519)	4 (0.001)	2,080 (0.52)
Togo	-	84 (0.021)	170 (0.043)	-	-	254 (0.064)	816 (0.204)	-	816 (0.204)
Uganda	-	4 (0.001)	334 (0.084)	-	-	338 (0.085)	724 (0.181)	-	724 (0.181)
Upper Volta	-	115 (0.029)	-	-	-	115 (0.029)	432 (0.108)	-	432 (0.108)
Zaire	-	98 (0.025)	4,180 (1.045)	-	-	4,278 (1.069)	3,104 (0.776)	800 (0.2)	3,904 (0.976)
Zambia	9 (0.002)	-	9,108 (2.277)	-	-	9,117 (2.279)	3,080 (0.77)	1,250 (0.313)	4,330 (1.083)
Zimbabwe	367 (0.092)	-	4,098 (1.025)	-	2,867 (0.717)	7,332 (1.833)	1,944 (0.486)	6,825 (1.706)	8,768 (2.192)

TABLE A-5 - BREAKDOWN OF COMMERCIAL ENERGY CONSUMPTION BY
ELECTRIC UTILITIES AND OTHER (1980 ESTIMATES)

GWh (Mtoe)
(Continued)

Name of Region Country	Electric Power						Other		
	Coal	Oil	Hydro	Nucl.	Other	Total	Oil	Other	Total
<u>ASIA</u>									
Bangladesh	-	880 (0.22)	600 (0.15)	-	1,432 (0.358)	2,912 (0.728)	5,316 (1.329)	3,592 (0.898)	8,908 (2.227)
Burma	-	407 (0.102)	773 (0.193)	-	335 (0.084)	1,515 (0.379)	3,648 (0.912)	1,691 (0.423)	5,339 (1.335)
Fiji	-	237 (0.059)	-	-	80 0.02	317 (0.079)	736 (0.184)	48 (0.012)	784 (0.196)
India	77,036 19.259)	2,384 (0.596)	49,155 (12.289)	3,170 (0.792)	-	131,745 (32.94)	106,208 (26.552)	171,416 (42.854)	277,624 (69.406)
Indonesia	-	6,929 (1.732)	2,635 (0.659)	-	1,424 (0.356)	10,988 (2.747)	74,600 (18.65)	16,080 (4.02)	90,680 (22.67)
Nepal	-	42 (0.011)	190 (0.047)	-	50 0.013	282 (0.071)	234 (0.058)	68 (0.017)	302 (0.075)
Pakistan	-	-	9,054 (2.264)	150 (0.037)	-	16,068 (4.107)	-	-	41,368 (10.342)
Philippines	-	13,124 (3.281)	3,753 (0.938)	-	2,770 (0.693)	19,647 (4.912)	31,396 (7.849)	1,636 (0.409)	33,032 (8.258)
Sri Lanka	-	360 (0.09)	1,500 (0.375)	-	-	1,860 (0.465)	3,552 (0.888)	4 (0.001)	3,556 (0.889)
Thailand	2,752 (0.688)	10,648 (2.662)	2,719 (0.68)	-	752 (0.188)	16,872 (4.218)	25,283 (6.321)	3,125 (0.781)	28,408 (7.102)

TABLE A-5 - BREAKDOWN OF COMMERCIAL ENERGY CONSUMPTION BY
ELECTRIC UTILITIES AND OTHER (1980 ESTIMATES)

GWh (Mtoe)
(Continued)

Name of Region Country	Electric Power						Other		
	Coal	Oil	Hydro	Nucl.	Other	Total	Oil	Other	Total
<u>LATIN AMERICA</u>									
Argentina	-	9,224 (2.306)	14,682 (3.671)	2,932 (0.733)	13,836 (3.459)	40,674 (10.169)	75,120 (18.78)	29,416 (7.354)	104,536 (26.134)
Barbados	-	349 (0.087)	-	-	-	349 (0.087)	424 (0.106)	28 (0.007)	452 (0.113)
Belize	-	83 (0.021)	-	-	-	83 (0.021)	160 (0.04)	-	160 (0.04)
Bolivia	-	188 (0.047)	1,155 (0.289)	-	332 (0.083)	1,675 (0.419)	4,032 (1.008)	1,064 (0.266)	5,096 (1.274)
Brazil	7,760 (1.94)	1,646 (0.412)	128,830 (32.208)	-	2,350 (0.589)	140,586 (35.149)	179,600 (44.9)	17,608 (4.402)	197,208 (49.302)
Costa Rica	-	155 (0.039)	2,140 (0.535)	-	-	2,295 (0.574)	2,800 (0.7)	-	2,800 (0.7)
Colombia	4,377 (1.094)	695 (0.174)	16,100 (4.025)	-	1,876 (0.469)	23,048 (5.761)	25,252 (6.313)	19,820 (4.955)	45,072 (11.268)
Dominican Rep.	-	3,204 (0.801)	481 (0.1202)	-	243 (0.061)	3,928 (0.982)	3,516 (0.879)	-	3,516 (0.879)
Ecuador	-	2,710 (0.678)	1,051 (0.263)	-	10 (0.003)	3,771 (0.943)	11,892 (2.973)	40 (0.01)	11,932 (2.983)
El Salvador	-	120 (0.03)	1,050 (0.263)	-	395 (0.099)	1,565 (0.392)	2,248 (0.562)	-	2,248 (0.562)
Guatemala	-	1,325 (0.331)	1,343 (0.336)	-	-	2,668 (0.667)	3,172 (0.793)	-	3,172 (0.793)
Guyana	-	452 (0.113)	-	-	48 (0.012)	500 (0.125)	1,624 (0.406)	-	1,624 (0.406)
Haiti	-	116 (0.029)	258 (0.065)	-	-	374 (0.094)	728 (0.182)	-	728 (0.182)
Honduras	-	288 (0.072)	640 (0.16)	-	23 (0.005)	951 (0.238)	1,964 (0.491)	-	1,964 (0.491)

TABLE A-5 - BREAKDOWN OF COMMERCIAL ENERGY CONSUMPTION BY
ELECTRIC UTILITIES AND OTHER (1980 ESTIMATES)

GWh (Mtoe)
(Continued)

Name of Region Country	Electric Power						Other		
	Coal	Oil	Hydro	Nucl.	Other	Total	Oil	Other	Total
<u>LATIN AMERICA</u> (continued)									
Jamaica	-	1,960 (0.49)	133 (0.033)	-	-	2,091 (0.523)	7,964 (1.991)	4 (0.001)	7,968 (1.992)
Mexico	2,972 (0.743)	42,616 (10.654)	16,970 (4.243)	-	5,603 (1.4)	68,161 (17.04)	198,964 (49.74)	88,292 (22.073)	287,256 (71.813)
Nicaragua	-	710 (0.177)	480 (0.12)	-	-	1,190 (0.297)	1,592 (0.398)	-	1,592 (0.398)
Panama	-	2,044 (0.511)	1,317 (0.329)	-	-	3,361 (0.84)	2,464 (0.616)	-	2,464 (0.616)
Paraguay	-	29 (0.007)	583 (0.146)	-	230 (0.057)	842 (0.210)	868 (0.217)	-	868 (0.217)
Peru	-	1,916 (0.479)	8,631 (2.158)	-	-	10,547 (2.637)	22,016 (5.504)	3,336 (0.834)	25,352 (6.388)

TABLE A-5 - BREAKDOWN OF COMMERCIAL ENERGY CONSUMPTION BY
ELECTRIC UTILITIES AND OTHER (1980 ESTIMATES)
GWh (Mtoe)
(Continued)

Name of Region Country	Electric Power						Other		
	Coal	Oil	Hydro	Nucl.	Other	Total	Oil	Other	Total
<u>NEAR EAST</u>									
Egypt	-	9,612 (2.403)	9,000 (2.25)	-	5,176 (1.294)	23,788 (5.947)	39,364 (9.841)	4,252 (1.063)	43,616 (10.904)
Jordan	-	1,237 (0.309)	-	-	-	1,237 (0.309)	5,615 (1.404)	-	5,616 (1.404)
Lebanon	-	109 (0.027)	225 (0.056)	-	-	372 (0.093)	-	-	-
Morocco	2,180 (0.545)	2,362 (0.591)	1,024 (0.256)	-	47 (0.012)	5,613 (1.403)	12,896 (3.224)	1,212 (0.303)	14,108 (3.527)
Oman	-	764 (0.191)	-	-	-	764 (0.191)	384 (0.096)	-	384 (0.096)
Syria	-	1,320 (0.33)	2,600 (0.65)	-	-	3,920 (0.98)	19,056 (4.764)	200 (0.05)	19,256 (4.814)
Tunisia	-	2,988 (0.747)	29 (0.007)	-	-	3,017 (0.754)	6,700 (1.675)	2,164 (0.541)	8,864 (2.216)
Yeman	-	228 (0.057)	-	-	442 (0.111)	670 (0.168)	892 (0.223)	-	892 (0.223)